L6: Entry 11 of 14 File: USPT Jul 23, 1996

DOCUMENT-IDENTIFIER: US 5538695 A
TITLE: Ozonizer

Brief Summary Text (11):
Japanese Patent Application Public Disclosure (KOKAI) No. 3-218905 proposes a method wherein 0.02% to 2% nitrogen gas is mixed with high-purity oxygen gas which is to be passed through an ozonizer to produce ozone gas having a high ozone concentration used to form an insulating film on a semiconductor wafer.

Brief Summary Text (12):
Japanese Patent Application Public Disclosure (KOKAI) No. 1-282104 proposes a method wherein 1.0 vol % to 10.0 vol % an inert gas, e.g., nitrogen, argon, helium, carbon dioxide gas, etc., is mixed with high-purity oxygen gas which is to be passed through an ozonizer to obtain ozone gas used for the purpose of ashing organic contamination and a photoresist which are present on a silicon wafer as measures to prevent a decrease in ozone concentration with time.

Detailed Description Text (8):
When the ozonizer 2 was operated by using the discharger 4 shown in FIG. 2 and oxygen of 99.5% purity as a raw material gas and setting the pressure in the discharger 4 at atmospheric pressure and the discharger cooling water temperature at 4.degree. C., ozone gas having a ultrahigh ozone concentration, i.e., 200 mg/Nl. or higher, was obtained at a flow rate of 1 Nl./min. However, the ozone gas thus produced cannot be used for processing a semiconductor product because oxygen of 99.5% purity may produce an adverse effect on the semiconductor product due to impurities contained therein.

Detailed Description Text (10):
In contrast, when only the cooling water temperature was changed to 15.degree. C. with other conditions being left unchanged, the concentration of the ozone gas produced stabilized at a high level of not lower than 100 mg/Nl, although it slightly lowered at the beginning (see FIG. 8).

Detailed Description Text (11):
It should be noted that although in this example water was used as a heat transfer medium, the same advantageous effect was also obtained when a substance other than water was used as a heat transfer medium.

Detailed Description Text (13):
Next, the ozonizer 2 was operated under the same conditions as in Example 1 except that the cooling water temperature was returned to 4.degree. C. and the pressure in the discharger was set at 1.1 kgf/cm.sup.2 (gauge pressure). As a result, the concentration of the ozone gas produced stabilized at a high level of not lower than 100 mg/Nl, although it slightly lowered at the beginning in the same way as in the case of the raised cooling water temperature.

Detailed Description Text (15):
When the cooling water temperature was raised to 20.degree. C. and the pressure in the discharger was set to 2.0 kgf/cm.sup.2 (gauge pressure), the concentration of the ozone gas produced stabilized at a

high level of not lower than 200 mg/Nl. from the first, and there was no lowering of the ozone concentration with time (see FIG. 8).

Detailed Description Text (17):
Thus, the present invention enables the ozone gas concentration to be stabilized at a high level when highly pure oxygen is used as a raw material gas by an extremely simple and easy method in which the cooling liquid temperature and/or the pressure in the discharger are raised, and it also enables ozone gas of high purity to be supplied to a semiconductor manufacturing process. Accordingly, it becomes unnecessary to prepare a mixed gas or to provide a gas mixing device. In addition, it becomes possible to prevent injection of an additive gas, e.g., N.sub.2, CO.sub.2, etc., which may have an adverse effect on the semiconductor manufacturing process, and a gas produced as a by-product from such an additive gas. Thus, the present invention provides great advantages.